RESULTS OF SPACE SHUTTLE FLIGHT 61-C

HEARING

BEFORE THE

COMMITTEE ON SCIENCE AND TECHNOLOGY HOUSE OF REPRESENTATIVES

NINETY-NINTH CONGRESS

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RESULTS OF SPACE SHUTTLE FLIGHT 61-C

TUESDAY, SEPTEMBER 23, 1986

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The committee met, pursuant to call, at 10:35 a.m., in room 2318, Rayburn House Office Building, Hon. Don Fuqua (chairman of the committee) presiding.

Mr. FUQUA. The committee will be in order.

Without objection, cameras and photographs will be allowed for the hearing.

It is a pleasure to welcome the crew of mission 61-C to the committee. It is also a pleasure to more formally welcome our fellow colleague back, Bill Nelson, who had the distinction of joining this crew for their outstanding mission.

As you may remember, this mission preceded the *Challenger* crew by some 14 days and launched several satellites and performed valuable experiments to add to the storehouse of knowledge gained through the space program.

Knowing the crew as I do, I am sure that they would launch tomorrow if they were asked. Since I believe their beliefs and dedication to the Nation's space effort, still among the strongest ever.

I will leave the introduction of the crew to one of their crew members but I would like to mention those people that are behind the scenes, and that's the wives or spouses of the crew. I would like to ask that Dr. Rhea Seddon, who was a member of flight 51-D back in April of 1985 and performed very valuable assistance and a rescue attempt on that satellite. Rhea, we are very delighted to have you here.

Also, Susie Nelson—not the wife of Congressman Nelson, but the wife of "Pinky" Nelson—is here, and I would like to ask her to stand and be recognized at this time.

And for all the fellow wives who go through these periods of great stress in a very professional and responsible manner, we are very delighted to have you here.

[The biographies follow:]

61-C Flight Crew

Robert L. Gibson, Cdr., USN, is mission commander. Born October 30, 1946, in Cooperstown, N.Y., Gibson became an astronaut in 1978.

He was graduated from California Polytechnic State University with a B.S. degree in aeronautical engineering. He entered active duty with the Navy in 1969 and completed advanced flight training at the Naval Air Station, Kingsville, Texas. While assigned to Fighter Squadrons 111 and 1, he flew 56 combat missions in Southeast Asia.

Gibson has flown more than 3,000 hours in 35 types of civil and military aircraft and holds commercial pilot, multi-engine and instrument ratings. He has completed over 300 carrier landings.

Gibson was pilot on Space Shuttle Mission 41-B in 1984. He has logged 191 hours in space.

Charles F. Bolden, Jr., Lt. Col., USMC, is 61-C pilot. He was born August 19, 1946, in Columbia, S.C. He became a NASA astronaut in May 1980.

Bolden received a B.S. degree in electrical science from the U.S. Naval Academy and an M.S. in systems management from the University of Southern California. After flight training he flew more than 100 sorties into North and South Vietnam, Laos and Cambodia. He has more than 3,400 hours flying time—3,100 in jet aircraft.

Bolden's NASA assignments include systems development group work on tile repair, SRB launch over pressure, launch debris prevention and Shuttle Autoland development. He also has served as astronaut office liasion for STS displays and controls, astronaut office safety officer and technical assistant to the director of flight crew operations.

George D. Nelson, Ph.D., is one of three mission specialists. Born July 13, 1950, in Charles City, Iowa, he became a NASA astronaut in 1978.

Nelson received a B.S. degree in physics from Harvey Mudd College and an M.S. and Ph.D in astronomy from the University of Washington. He performed various astronomical research projects at Sunspot, N.M.; Utrecht, the Netherlands; and Gottingen, West Germany. He was a post-doctoral research associate at the Joint Institute for Laboratory Astrophysics in Boulder, Colo.

Nelson was a mission specialist on STS 41-C in April 1984. During that flight, the crew deployed the Long Duration Exposure Facility, retrieved and repaired the ailing Solar Maximum Satellite, then placed it back in orbit with the robot arm. He has logged 168 hours in space, including 9 hours of EVA flight time.

Steven A. Hawley, Ph.D., mission specialist, was born December 12, 1951, in Ottawa, Kans. He became a NASA astronaut in 1978.

Hawley received B.A. degrees in physics and astronomy from the University of Kansas and a Ph.D. in astronomy and astrophysics from the University of California. He was a postdoctoral research associate at Cerro Tololo Inter-American Observatory in La Serena, Chile.

Hawley was a mission specialist on STS 41-D in 1984, completing 96 Earth orbits and logging 144 hours in space. He served as simulator pilot for software checkout at the Shuttle Avionics Integration Laboratory before STS-1 and as a member of the astronaut support crews for the second, third and fourth Shuttle flights.

Franklin R. Chang-Diaz, Ph.D., mission specialist, was born April 5, 1950, in San Jose, Costa Rica. He became a NASA astronaut in 1980.

Chang-Diaz was graduated from Colegion De La Salle in San Jose, Costa Rica in 1967. He received a B.S. degree in mechanical engineering from the University of Connecticut and a Ph.D. in applied plasma physics from the Massachusetts Institute of Technology in 1977.

In addition to his mainline fields of science and engineering, Chang-Diaz worked 2½ years as house manager in an experimental community residence for deinstitutionalizing chronic mental patients and was heavily involved as instructor/advisor with a rehabilitation program for Hispanic drug abusers in Massachusetts.

Robert J. Cenker is one of two payload specialists on 61-C. Born in Uniontown, Pa., he graduated from St. Fidelis College and Seminary, Herman, Pa. He received B.S. and M.S. degrees in aerospace engineering from Pennsylvania State University and an M.S. degree in electrical engineering from Rutgers University.

Cenker is a senior staff engineer at RCA Astro-Electronics Division, East Windsor, N.J. Much of his career has been devoted to design and development of communications satellites including RCA Satcoms 1 and 2, the GTE Spacenet satellites and the advanced series 4,000 spacecraft.

The first of these satellites, designated RCA Satcom Ku-Band-1, will be deployed during 61-C and Cenker will perform experiments with an infrared camera developed at RCA's David Sarnoff Research Center, Princeton, N.J.

C. William (Bill) Nelson, Congressman, 11th District of Florida, is a payload specialist on 61-C. He is a fifth generation Floridian whose family came to Florida in 1829. He is chairman of the Space Science and Applications Subcommittee and a member of the Banking, Finance and Urban Affairs Committee.

Nelson received a bachelor of arts degree from Yale University and a degree in law from the University of Virginia. A U.S. Army captain, he served in the reserves from 1965 to 1971 and was on active duty from 1968 to 1970.

In 1972, he was elected to the Florida legislature and served 6 years until his election to Congress. He was honored by the Florida Jaycees as one of the five outstand-

ing young men of Florida, and was nominated as the most valuable member of the Florida House of Representatives.

Mr. FUQUA. Now I would like to ask Congressman Lujan for any remarks that he wishes to make at this time.

Mr. LUJAN. Thank you very much, Mr. Chairman, and I want to join you in welcoming the crew. For a couple of years you will have the distinction of being the last crew up in—in the shuttle, and we hope that you don't hold that distinction for—for very long.

I just want to take this opportunity, Mr. Chairman—we have a group of—of visitors, and I would like to extend a welcome to the fifth grade class of Camelot Elementary School from Annandale, VA, and they are accompanied by their fifth grade teachers: Miss Clark, Mrs. Cagle, and Mrs. Tarr. And we just want to welcome them. They all want—want to be astronauts. And as we were talking about that, Steve said, well, you know, they may think now, well, heck, if you can do it, anybody can. But I don't think that that's quite—quite the situation. You make a—a good example for them to follow.

And thank you, Mr. Chairman.

Mr. FUQUA. Thank you, Mr. Lujan.

And now I'd like to recognize our own Congressman, Bill Nelson, for introduction of the—of the crew.

STATEMENTS OF HON. BILL NELSON, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF FLORIDA, PAYLOAD SPECIALIST; CDR. ROBERT L. GIBSON, U.S. NAVY, MISSION COMMANDER; COL. CHARLES F. BOLDEN, U.S. MARINE CORPS, PILOT; GEORGE D. NELSON, MISSION SPECIALIST; STEVEN A. HAWLEY, MISSION SPECIALIST; FRANKLIN R. CHANG-DIAZ, MISSION SPECIALIST, AND ROBERT J. CENKER, PAYLOAD SPECIALIST

Mr. BILL NELSON. Thank you, Mr. Chairman.

This is an honor for me to introduce six very good friends, people who were personally so helpful to me throughout all the training and then the better part of a month of scrubs, and then finally, 6 glorious days in space.

I want to introduce first Bob Cenker, who is an RCA engineer. He was the payload specialist No. 1. Bob is from New Jersey. One of the little vignettes that I remember on orbit so much about Bob is one—one evening after the third meal of the day, Bob was just completely exhausted, and he just fell asleep floating. And none of us wanted to wake him up, and he was just in a dead sleep.

I was the last to get into the sack and Bob was floating at about head level where I had my sleep restraint attached to the lockers. And I thought, well, he's going to keep bumping into me all night, so I don't want to keep waking up, so we can fix this. So I—I went and got something that is one of the most useful items on space: a piece of gray sticky tape. Tore it off about that long and attached one end of it to a wire that was coming out of Bob's flight suit, and then floated him ever so gently across the cabin and stuck him to the wall. And there he slept for 8 hours in a very restful sleep.

It's my pleasure to introduce Franklin Chang-Diaz, a mission specialist 3, a Ph.D. in plasma physics. At age 7, Franklin decided he

wanted to be an astronaut—living in Costa Rica. He came to the United States after high school, and didn't speak much English, taught himself English—and you see the result: a Ph.D. from MIT.

Franklin has been dubbed as the first Hispanic American to fly and since then there has been quite a fiesta all around the Western Hemisphere. Indeed, Franklin conducted a live interview while we were on orbit with the President of Costa Rica. And all of this was done in Spanish. The President said to Franklin, well, I was just talking to a campesino the other day, and we wanted to know what you eat in space. And it just so happened that Franklin had brought along a package of tortillas, and he had them taped to the locker. And so right there in front of the live television camera, he reached over, he pulled out the tortillas, he said, Mr. President, we eat tortillas in space.

Mission specialist 2, Steve Hawley. Steve has one of the quickest wits—he just kept us laughing the whole time. And he's also known as the fellow who knows the flight rules more than any other astronaut. Despite all of his knowledge, we were really getting worried about ever getting up because we had gone through four scrubs, and when you combine that with all of Steve's previous scrubs from his previous mission, one of which they actually had the engines ignited and went down to 2 seconds before T minus 2—when the automatic sequencer shut off the engines. And so we were really wondering, was this a jinx? Were we ever going to get off? Because here we were the most delayed shuttle flight in the history and then to boot, had four scrubs.

So that fifth time when we climbed in, lo and behold, it wasn't Steve climbing into the orbiter. He put on a Groucho Marx disguise. He took a piece of gray sticky tape and put it over his name tag and he fooled Columbia—Columbia did not know that it was Steve Hawley, and we launched that day.

And then to my namesake, Dr. Pinky Nelson, an astronomer, Ph.D., as is Steve Hawley. Pinky Nelson, I think—if I had to—to describe an individual that would just enjoy zero gravity more than any other individual, I think it would be Pinky. On orbit he was all the time doing some kind of acrobatic maneuver, or showing us some particular thing about zero gravity. Pinky was the first one to be so helpful to Bob Cenker and me. As some of our apparatus would break down, Pinky was right there to help us correct it and to repair the machinery.

I don't think that any other crew could imagine of having a leadership team, as much of a team as our commander and our pilot were. Indeed, the teamwork with all of the professional astronauts, was just incredible. It was so true of Charlie Bolden, our pilot, who, on that descent, was just like a chatterbox, giving Hoot the readings, talking him down, giving him encouragement—and it was—it was a real team effort.

Charlie is a graduate of Annapolis. Way back in the 1960's, Charlie was the president of the freshman class at Annapolis. And since then, he has continued that record of excellence.

And then all of us could say in the introductions, Mr. Chairman, we had an absolutely outstanding commander in Hoot Gibson: a Navy test pilot, a Vietnam veteran, someone who offered us the leadership that it's pretty hard to lead this bunch. And Hoot

Gibson did it with elan, with aplomb, with a good measure of humor, and yet, with an exceptional amount of knowledge that we all respected.

And when he greased it in in that unexpected night landing, right down on the center line, he was right on the money.

So, Mr. Chairman, it is a pleasure for me to introduce to your committee this crew of 61-C.

Mr. FUQUA. Thank you very much, Bill.

Hoot, are you still the commander of this unit? And if you are, we will let you take over for any type of presentation that you wish to make.

Commander GIBSON. Thank you, Mr. Chairman. Bill, thank you for that—for that very warm and very heartfelt introduction.

Mr. Chairman, members of the committee:

We are very honored to be here today and we are very happy to be back together again as a crew. Of course, this debriefing has been delayed quite a substantial amount of time by the events of 1986. And ordinarily, this would have occurred about 8 months ago.

But we are, nevertheless, very happy to get back together as a crew since the events of this year have pretty much split us apart.

We have been very eager to start focusing again on a positive side of space flight, to focus on the manned space program, and the fact that we will fly again—that we will come back from our setbacks that we've had this year. And as the crew of NASA's last successful manned flight, we've been very eager to tell our story. And as we are thinking again of rebuilding, we felt that perhaps the time was right for us to talk about mission 61-C.

And with that, if we could lead in with the movie.

We were originally assigned early in 1985 as the crew of Mission 51-I. The five NASA crew members were assigned originally to 51-I and we moved to Mission 51-L, Mission 61-B, and finally arrived at Mission 61-C, which is the flight, of course, that we wound up flying.

Along the way—and you can go ahead and start the movie, please.

[Film.]

Commander GIBSON. Along the way, of course, we picked up Bob Cenker and our Congressman, Bill Nelson. And we set all-time records, I'm afraid, for the most number of aborted flights, as Bill has already mentioned. We took five tries to get off the launch pad. We underwent four scrubs and so, of course, we did five final breakfasts before going out. And this is our fifth and final breakfast before the day that we finally got to launch January the 12th, of course, earlier this year.

This is us walking out.

You might tweak the focus on that just a little bit.

You can see Bill was quite ready to go. [Laughter.]

We walked out at about 4 o'clock in the morning aiming for our 7 o'clock liftoff.

Colonel BOLDEN. This is *Columbia* on the pad. You can see we are getting ready for main engine ignition. Being a first-time guy to fly, it was kind of very interesting to me, the fact that you knew the main engines had lit because you could see it on the gauges but

the thing that really got your attention was when the solid rocket boosters ignited and lifted us off the pad.

It's about 7 million pounds of thrust that gets us off the launch pad. And I have to admit, I was somewhat surprised at the ease of the launch. I was able to actually raise my arms and move around—could actually move my head pretty freely.

We did our roll program and started to go into daylight because it was a very early morning launch—almost in darkness.

The views, I guess, were the things that were the most spectacular to me. The few times that I was able to peep up—Hoot had told me to stay down in the pit and watch the gauges so that's what I tried to do most of the time.

We are coming up on solid rocket booster separation, which occurs about 2 minutes into the flight. But, again, was a very interesting occurrence because you could hear it and you saw the flash of fire go across the forward wind screens as the solid rocket booster separated.

We flew under powered flight on the three main engines for another 6½ minutes until we finally got to what we call MECO, or main engine cutoff, that put us actually in space. That was the first time that we had an opportunity to sense weightlessness for Franklin, Bill, Bob, and me.

And that was when I raised my seat up and I was actually able to look out and see the Continent of Africa coming up—a most spectacular sight. And this was our first orbital view here.

Dr. HAWLEY. Mr. Chairman and members of the committee:

Our flight was important in a number of ways, I think, not the least of which was we really had an opportunity to try to demonstrate the shuttle as a platform for doing science. We had a variety of scientific experiments onboard, many of which were low-cost derivatives of earlier projects that had been flown by other means—for example, sounding rockets, including a material science laboratory, which are those cylinders you see there, and an ultraviolet astronomy experiment which I conducted with Pinky and Franklin, which subsequently we learned was very interesting and successful.

Dr. CHANG-DIAZ. Probably the most important payload we had on board was the RCA satellite, which we launched on day number one toward the end on orbit No. 7. This is what you see right here—the opening of the sun shields that protect the satellite when it is powered down. Pretty soon after that, the events happened very quickly. The last 15 minutes before deploy are minutes of very intense activity, and the most important thing to say is that it really is a team effort. And Pinky is up in front working all of the displays and controls, and I am backing him up in the—in the switches in the back.

You see, the satellite spins at about 55 rpm and then is ejected with springs and later on a timer will ignite the booster to get it up into the geosynchronous orbit.

Dr. GEORGE NELSON. One of the tasks that we do after the satellite is deployed is to try and track it for as long as we can to make sure that it's healthy for as long as we can see it.

Forty-five minutes after the satellite leaves the bay, the solid rocket that's on the bottom of the communications satellite there fires to lift the satellite from a 175-mile orbit that the shuttle is in

up to the 22,000 mile geosynchronous orbit. So even after the satellite is deployed there's a lot of activity that goes on.

Once that was done we went into other scientific experiments on board. Steve Hawley and I attempted to use an image intensifier to photograph Halley's comet. That was, unfortunately, unsuccessful because the image intensifier had failed. And we made numerous attempts but none of them were successful.

Colonel BOLDEN. This was kind of an interesting time because they had asked me to pass a book to Hoot and I quite naturally forgot that things float in space, so I handed it to him and you will see that come up here momentarily. We were hoping to demonstrate how well things float and I flunked the first test there. So, Hoot showed me how to do it.

Some of the aft flight deck activity. And Pinky has a 35-millimeter camera mounted in one of the overhead windows and that was what was to have been the comet Halley active monitoring program that did not work.

This was probably one of the things that was the most fun as a member of the crew, it's taking photos and observing the earth. Pinky was using a 70-millimeter Hasselblad at that time.

We are coming up on the country of Burma and the Irrawaddy River. Some of you who are former naval aviators can probably remember the jokes about Rangoon and that area.

Dr. CHANG-DIAZ. And the fact that we took so many pictures meant that somebody had to keep those cameras loaded and the film fresh so that we can photograph things very quickly as they pass by our windows. And that was my job.

We had three different kinds of film, cameras, and two of a kind. So there were about six cameras in total that I had to keep loaded up. And it was sort of an interesting exercise to take pieces of film, cartridges, and just leave them floating there. [Laughter.]

Mr. CHANG-DIAZ. And then you can do a lot of things at the same time. You kind of get used to working and letting the zero G work for you rather than against you.

By the end of the mission, we had actually exhausted the entire supply of film we had.

Mr. CENKER. As the member of the crew who probably had the biggest trouble adapting to zero G, the space adaptation syndrome, I was a candidate to perform the tests on the eye-hand coordination. That was one of the experiments.

Pinky and I were here working on another of the experiments that Congressman Nelson and I performed, that turns out had developed a broken wire. So Pinky and I had to try to repair that in flight.

Dr. GEORGE NELSON. This was the first flight of *Columbia* after some very major modifications and one of the interesting things that happens to the space ship when it gets out of the atmosphere is that it changes its shape in the cabin fairly dramatically since it's pressurized. We do a series of measurements there to determine how much the cabin is flexed and bent in space.

This is the commander getting some exercise on the treadmill. It turns out that's something that really helps your attitude and makes you feel a lot better being in space to be able to get on the treadmill and run.

Meal time is always an enjoyable time in space. And we usually worked in teams of two to get dinners ready, and we would stick the trays on the wall and fill them up, and then when it was time to eat we would get ready. The commander had been up doing some star-sighting, so now he's putting the star-sighter away there and getting ready for a meal.

Mr. CENKER. I got a little bit up on the flight deck here—this is lunch up on the flight deck, and you can see Pinky and Steve sort of propped up eating their meals. I've forgotten where the next scene comes from—I believe we now go down through—we are going down head first, if you will, into the middeck and you can see someone stuck up there in the corner. That was a position that I found particularly comfortable for eating because it kept me from moving around. I also slept propped up in there a couple of nights for the same reason. [Laughter.]

Dr. HAWLEY. Near the end of the mission, of course, it's time to put all the gear away, ready to come home. Bill's in the background putting away part of the treadmill apparatus. And I'd invite you to note the distinction between the way the professional 300 hours in space crewman develops a rapport with his equipment and contrasted with the rookie, Congressman Nelson. [Laughter.]

Dr. HAWLEY. You develop an uncanny ability to truly understand how your equipment functions. [Laughter.]

Colonel BOLDEN. As Steve said, it's time to come home. We had all had a good time. We attempted on 3 different days to come back. Each time we had to clean up the vehicle. It was our intent to leave it in better shape than we had gotten it. So we are using some things that I would consider high-tech here—some Handiwipes and Kleenex tissue, and things of that nature.

As you fly and learn about how you perform, you notice that food, when allowed to get loose, will go any and everywhere in the cabin, as will drinks if you allow them to migrate up through the straw. So before we came home we had quite a bit that we had to clean up from the cabinets and the walls and the floors and everything.

This was what we call tail-to-sun attitude. It was our last, I think, sunrise—absolutely gorgeous. The picture does not do it justice. The colors that you see in space are just—they are not indescribable, but it's very difficult to adequately describe it.

And you also get a—just a teeny touch of the big bulb on—on the top of the tail that was one of the aerodynamic experiments we had.

This is the landing. Hoot did an absolutely superb job. I'd have to echo what Bill said in that regard. It was a night landing, an unplanned night landing, at Edwards Air Force Base, because the weather at the Kennedy Space Center had been bad on the succeeding days and that morning.

It did not present any problem to Hoot, I think primarily because when he set up our training schedule he had planned for us to train about 50 percent of our time at night. And once we got overhead Edwards Air Force Base it was just like being in the shuttle training aircraft and it was old hat.

We tried to talk to each other and just pretend we were back in the STA, or the shuttle training aircraft, and that made the land-

ing almost routine. We all had to check and make sure that we were on the deck because it was so smooth.

The rollout, as you can see, gives you quite a bit of evidence of how dark it really was at Edwards that night. There was no Moon, as I remember. From being airborne, there's lots of light, but on the deck it was really dark.

About a little more than an hour later, we had finished shutting down the vehicle and doing a preliminary medical check. And this is the crew coming out of the orbiter and being greeted by the folks from the Kennedy Space Center and Johnson Space Center, and the fire and rescue guys, out at Edwards.

You can see that we walk pretty well. We had gone down and done deep knee bends and everything on the middeck, and other than the fact that your gyros may have been a little bit uncaged, it felt really good. [Applause.]

Commander GIBSON. Thank you. If we could bring the movie down and bring the slides up, we have about 10 or 12 slides that we would like to run quickly through.

If we could dim the lights perhaps just for a few more minutes.

Can we try and dim the lights again, please?

This is just the way my crew responds. [Laughter.]

Commander GIBSON. Thank you.

NASA National Aeronautics and Space Administration

Lyndon B. Johnson Space Center
Houston, Texas 77058

S1-C-14-08

FIGURE 1

Commander GIBSON. This was our official on orbit crew photo (fig. 1) that we shot after 5 days in space and you can see by the smiles that orbit can be a very enjoyable experience, and that the entire flight was a tremendous amount of fun for us.

You might try focus just a little bit on that, please.

We have George, the auto pilot, watching it at this point.

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FIGURE 2

Mr. BILL NELSON. This is the cancer research experiment sponsored by the University of Alabama Comprehensive Cancer Center (fig. 2). It is taking liquid protein, some of which has a link to cancer, into the zero gravity of orbit, and growing the hardened crystals in that environment in order to—once we bring the crystals to see if the crystals are not pure, so that through x-ray defraction you can try to determine the molecular structure or architecture of the proteins, which thus far has eluded the researchers.

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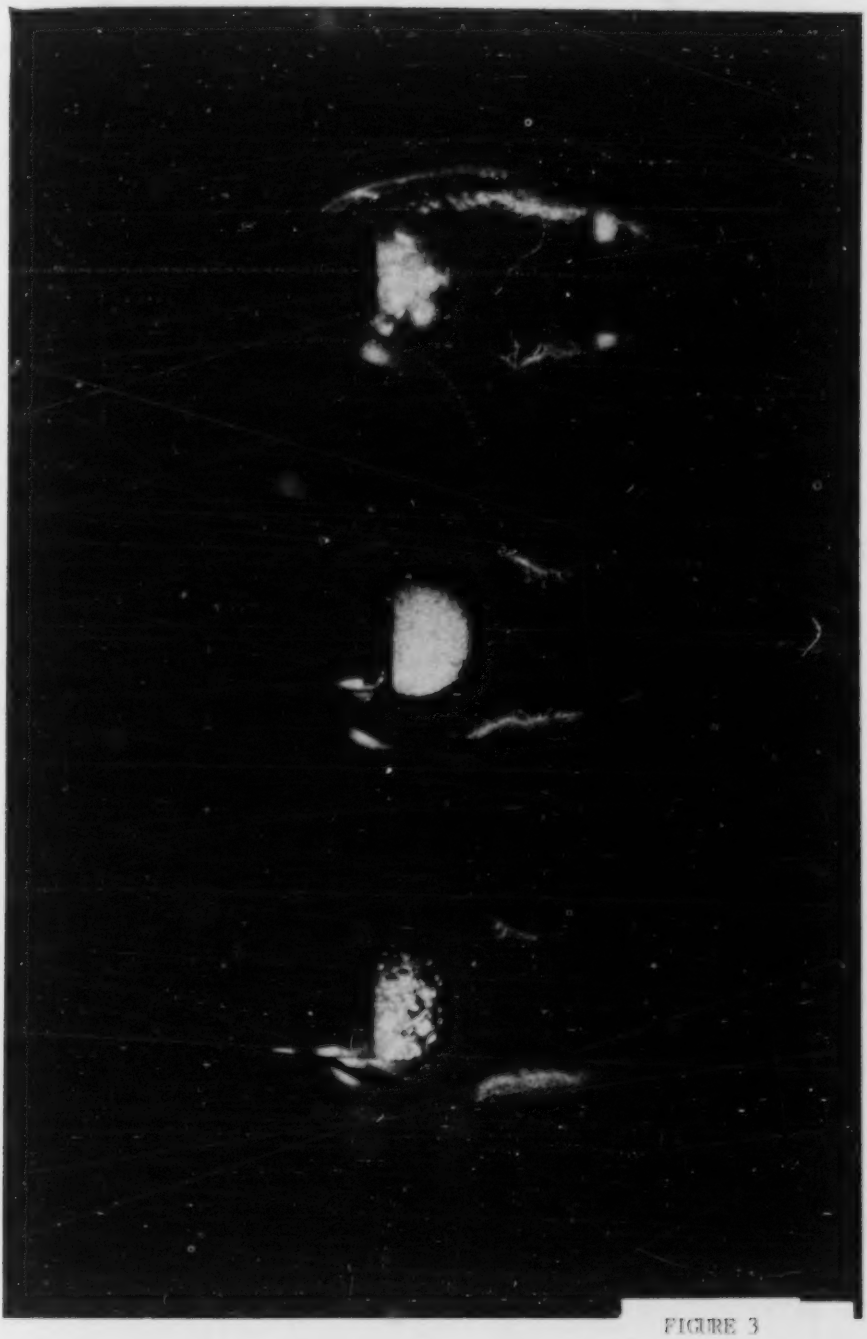

FIGURE 3

Mr. BILL NELSON. We grew hundreds of crystals here and brought them back (fig. 3). A couple of them—canavanine and concanavanine—have been defracted for the first time and that architecture is now known. And, Mr. Chairman, there's a—a paper that is beginning to be published in a medical journal on the results of this experiment.

It is one of the most promising uses of space in the future, just by virtue of the results that we had from this.

These are some photographs of the crystals that are growing. You can see particularly in the drop on the right, the crystals are forming. And that's a photograph about flight day 2.

FIGURE 4

Mr. BILL NELSON. This is another medical experiment (fig. 4). We were trying to determine for the first time the pressure of the blood as it flows into the right chamber of the heart. The little pencil-like device in my right hand is a sophisticated Doppler. It is—it is—it is enabling me to hear the blood rushing through my jugular vein. And then in blowing in the machine I'm cutting off that flow, and just as that flows cuts off you can calculate back and detemine what is the pressure of the blood there.

This was the first time this experiment has been run in space.

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FIGURE 5

Mr. BILL NELSON. And another first was—this is the first American stress test (fig. 5). I ran for 40 minutes. Had planned only to run for 25, and then discovered that one of the tape recorders had malfunctioned, so I continued to run for another 15 so we could get some of the data—and the data was all useful.

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FIGURE 6

Dr. GEORGE NELSON. As Charlie mentioned, one of the real delights of space flight is to get the opportunity to watch the earth (fig. 6). We do a number of planned observations that we get briefings from geologists and oceanographers and meteorologists prior to the mission, and have certain objectives.

One of the objectives on every flight is to try and photograph as many active volcanos as you can. On flight 61–C we were able to document seven active volcanos on the planet during the mission.

This one is called Massaya and is located in Nicaragua. The lake on the right-hand side is Lake Managua and Lake Nicaragua is on the left. And we were able to document this not only with hand-

held photography you see here but also with the infrared camera that was on board.

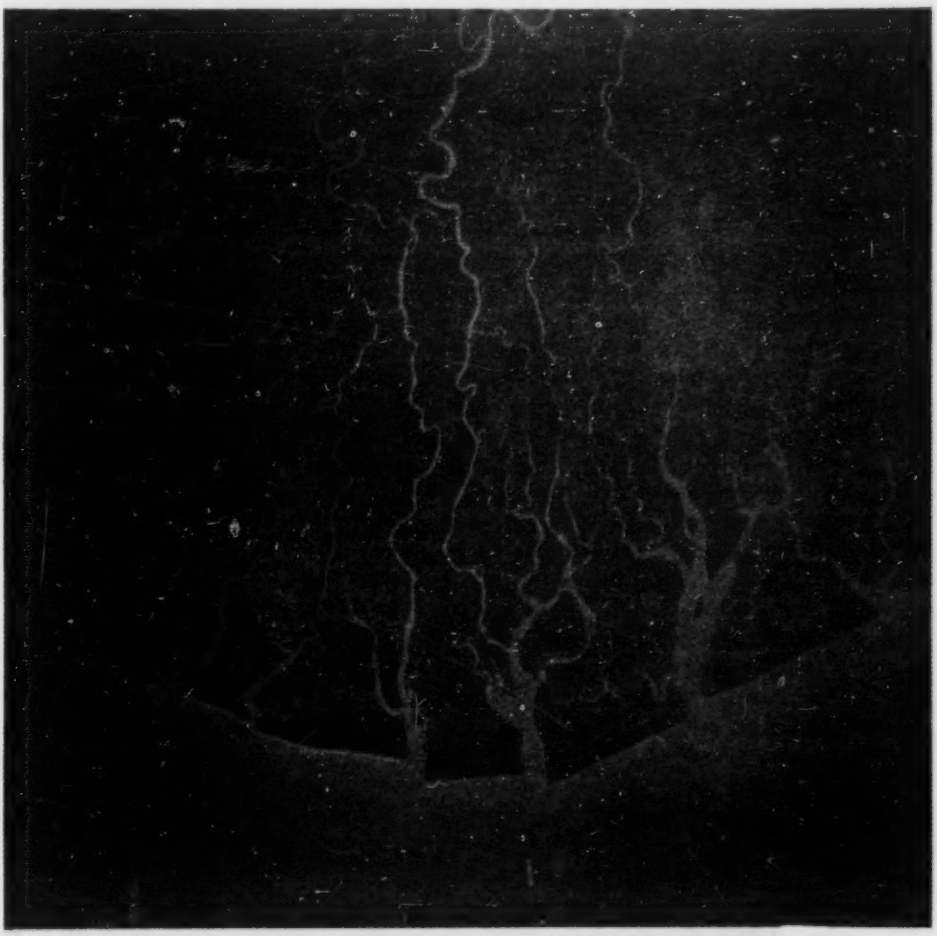

FIGURE 7

Colonel BOLDEN. This is kind of my favorite earth observation slide of the thousands that we took (fig. 7). And I want to brag on Pinky because this is the Niger River Delta. As the Niger River kind of winds its way down through the country of Niger in West Central Africa and then goes down through Nigeria and empties out into the Atlantic Ocean.

We have always wanted to get a picture of it but in the history of American space flight, either because of cloud cover or darkness, or something, this type of photo had never been taken. And on our flight, Pinky took a series of slides, or pictures, of the Niger River Delta, that gave us a good appreciation for what it's really like.

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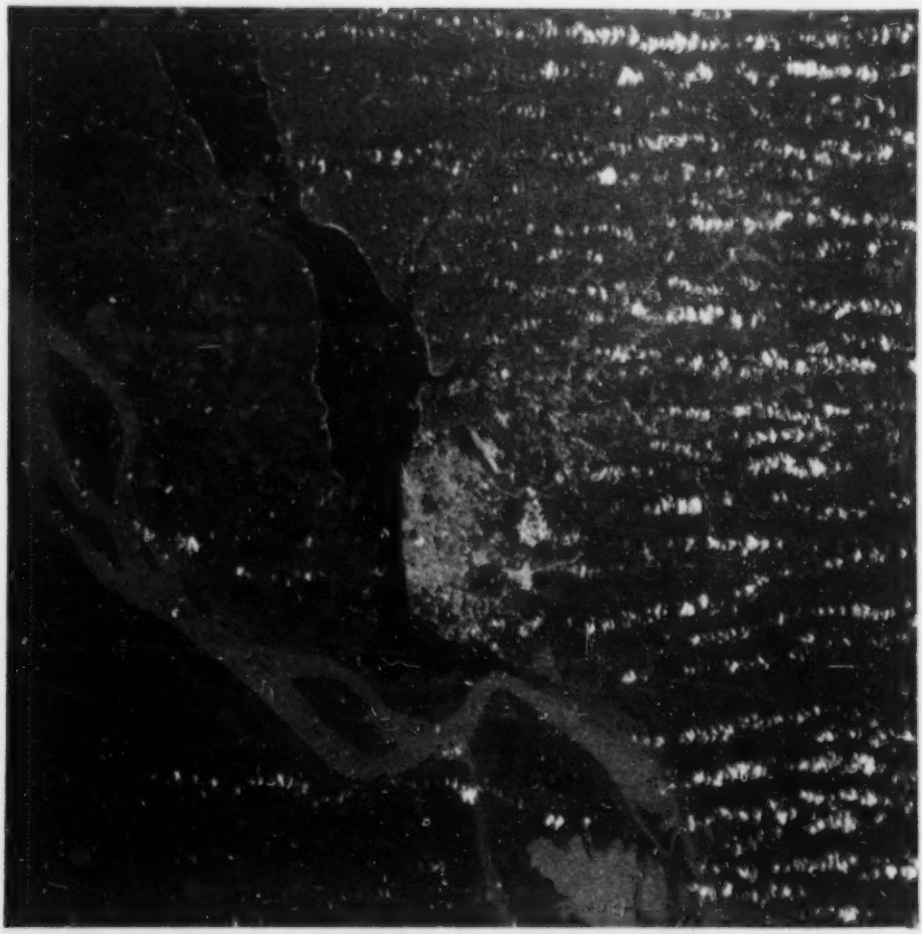

FIGURE 8

Dr. CHANG-DIAZ. Let's see—this is the city of Rio de Janiero in Brazil, Southeastern Brazil (fig. 8). And it was just a pretty picture. We shot it. It was unusual to see it that clear—normally it's cloudy. And actually, if you look at it with the naked eye you can see a lot more structure. You can see a causeway extending across the bay near the neck—narrow part of the bay. And you can also even see lots of ships in that bay, which cannot be seen here in the picture. So that's one of the neat things about Earth observations, that the eye, the human eye, can do a great deal of integration on land areas that we already know a little bit about.

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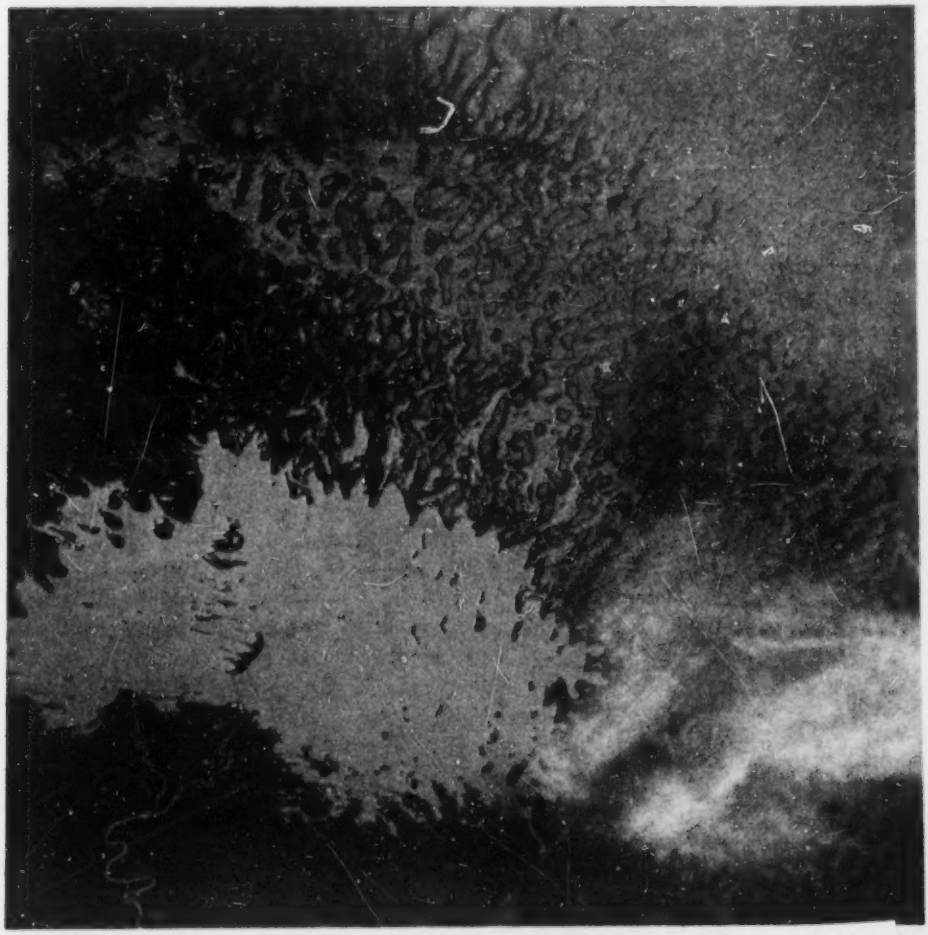

FIGURE 9

Dr. CHANG-DIAZ. This is another one in Brazil, central part of Brazil (fig. 9). The confluence of two rivers, well-known river, the Amazon, which is the brownish color one. And then there is Rio Negro, which means black river, for obvious reasons. And the two come together right there east of the city of Manaus, which is what you see there.

We took a lot of pictures of the Amazon basin and saw a lot of deforestation going on in that area.

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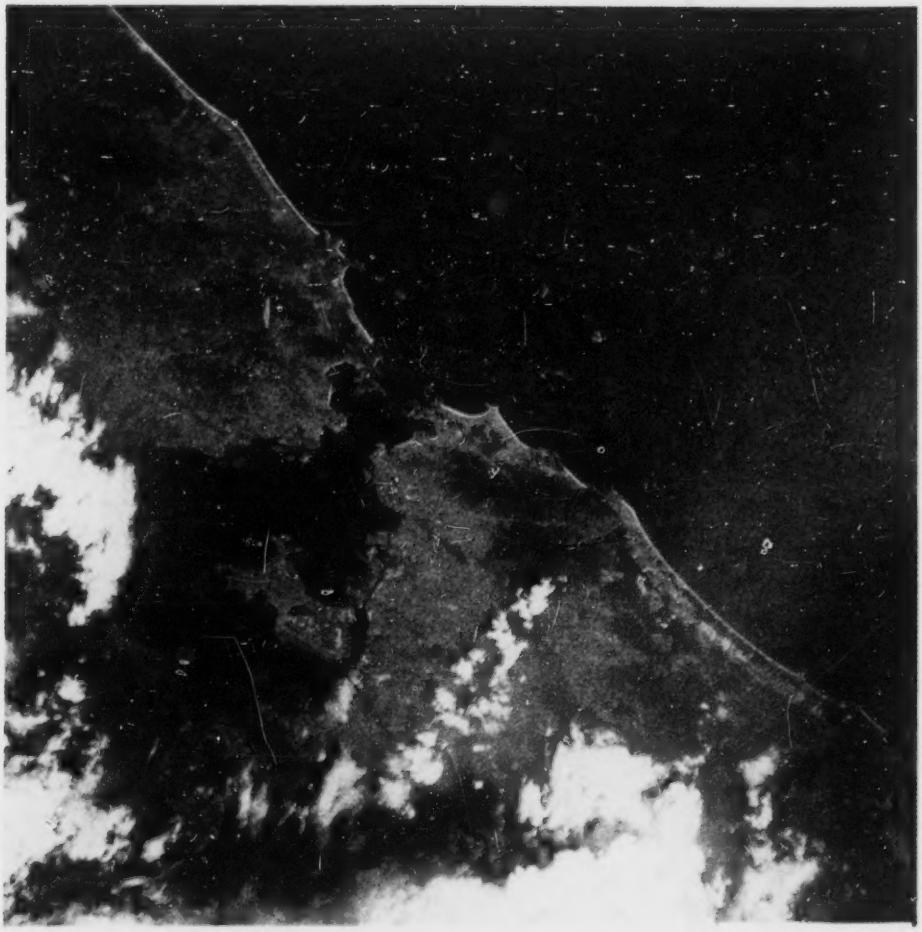

FIGURE 10

Dr. HAWLEY. This is a slide that we took of Lake Chad in Africa (fig. 10). And we included to make a point about the utility of using the shuttle for a continuing program of monitoring features on the Earth surface and how they evolve. In all of our previous flights—Hoot's and Pinky's and mine—Lake Chad was an object of interest owing to the long-term drought in Africa. And we had taken some trouble to monitor the water level a couple of years before 61-C.

And it was obvious to all of us, even at first glance, that the water level in Lake Chad had risen substantially since the last time we had had a chance to see it, and we were able to document it in the photographs.

In fact, I suspect that some amount of quantification of the phenomenon is possible by comparing photographs taken in similar ways using similar equipment from previous missions.

However, the point that we'd like to make is that it is useful and is demonstrable that the shuttle does represent a way to monitor

long-term climatological effects on the Earth's surface. And that information is useful and it's made available to the proper people.

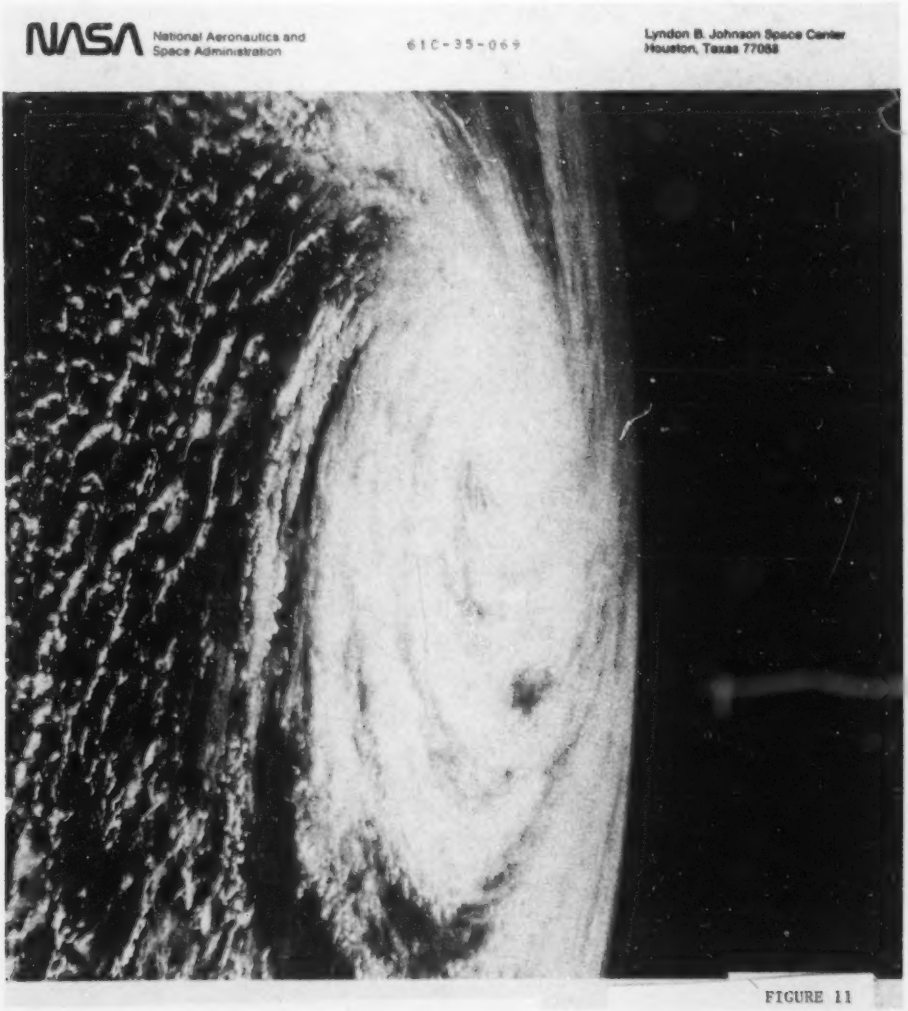

FIGURE 11

Commander GIBSON. This is a photo—and this is our last slide—of hurricane Delifinina, which was off the west coast of Australia, and was raging when we first launched up into orbit (fig. 11). Over the course of the 6 days that we spent in orbit, we had an opportunity to observe the dying off of a hurricane and actually photograph the storm at intervals throughout the flight as it gradually decayed.

By the time we were ready to land at the end of our 6 days up there, we could not find any trace of hurricane Delifinina, so it was an interesting event to be able to watch and photograph over the course of it.

If we can bring the slides down and the lights back up.

[Pause.]

Commander GIBSON. Once we have the lights down we can't bring them back up.

Mr. FUQUA. Could the light person flip the switch?

Thank you.

Commander GIBSON. Well, Mr. Chairman, that was what we had set out to accomplish on 61-C and what we in fact did accomplish. We need to continue, we feel, to utilize space to do the things that we do so well in space—the weather satellites—just as we were able to observe hurricane Delifinina during our time in space, it is perhaps significant to note that since the year 1966, there has not been a single tropical storm or hurricane that has escaped detection because of weather satellites.

Of course, all of us utilize communication satellites in our everyday life, but beyond that there will always be a place in space for men and women to do the things that humans do best: to adapt, to innovate, to replan, to adjust, and to direct machinery in what we want it to do.

The United States has always maintained a very strong leadership role in space. But we won't keep our preeminent position just because of what we have done in the past. We will only do it by what we do today and in support of what's to come in the future.

The space station and the rebuilding of NASA and of the shuttle will ensure our preeminence in space and guarantee that we continue to derive the benefits from space utilization.

Our friends who were aboard the *Challenger* understood the benefits from space just as they understood the risks in daring to do what they did. We owe it to them to continue our strong support of the dream they lived for and to continue in our role as the greatest Nation on and above this Earth.

Thank you, Mr. Chairman.

Mr. FUQUA. Thank you very much, Hoot. And it seems that from the movies and the shots and talking to everybody, that you had a great time on that flight. And knowing each of you as I do, I am sure you did.

I want to congratulate you, particularly on your statement—I think we have to look ahead. There was a movie at the Smithsonian just recently about space that "The Dream is Alive." And I think we should not forget those words even though we've gone through tragedy, but the dream is alive. And it's our responsibility to make sure that that dream stays alive.

Man is going to continue to explore new frontiers. And I'm sure as you could see out there, there's a lot of frontier to explore. And I hope that in the coming years that the space program continues to expand and move to meet those challenges that we have facing us.

It would be a very stagnant society if we just were content to live in our own little hut or cave and never try to move beyond that. And we have done that. We've led the world and we can continue to do that. But not only just from leadership and pride, but also the scientific information that is derived from many of the things that you are involved in, and whether it be medical research or understanding better the life that we live in today.

So let me congratulate you and all the other members of the astronaut corps and those that—many thousands of people that sup-

port you, and also the taxpayers that foot the bill, to do that. I think it's also in their benefit.

I don't have any questions.

Mr. Lujan.

Mr. LUJAN. Yes, just a couple of—of things that occur to me. I, too, want to join you in congratulating the entire group. You are just a very special kind—kind of people to do what you do to do what you want to do what you do and we are all very proud of you.

How long do you stay on that treadmill? I'm new to this exercise business in the last 6 months. How long do you stay on the treadmill, and does that have the same effect on your heart that it does here?

Commander GIBSON. Well, I wasn't after any records, sir, so I didn't spend near as much time on it as Congressman Nelson did.

Mr. LUJAN. No, what do you usually do? You know, 5 minutes, 10, 15, 20?

Commander GIBSON. Fifteen to 20 minutes is usually a pretty good time. And what we are attempting to do is get our heart rate up to the kind of heart rates that we would see when we run here on the Earth. And by way of accomplishing that, we have some very large bungies that put about 160 pounds of force on you simulating gravity and simulating what your weight would be here on Earth.

And I think it does a very good job of simulating what a run would be like on the earth. And perhaps Congressman Nelson might have more to add on it after his 40 minutes.

Mr. FUQUA. Who was the prankster that turned the recorder off when Bill Nelson was doing his running?

Mr. BILL NELSON. It was a—I opened up that recorder and it was scrambled eggs in there. It was just—it was not correctly threaded before we ever launched.

Mr. FUQUA. So you exonerated the other crew members?

Mr. BILL NELSON. Oh, indeed.

The—I found it more difficult to run on a treadmill up there because of having to hold yourself down. And I guess what added to the difficulty was that I had a malfunctioning monitor which showed that the harder that I ran, that my heart rate was actually going down. And, therefore, since the whole idea was to run for a sustained period of time between 75 and 85 percent of your normal top heart rate—your max heart rate—I mean, I was hauling buggy. And—and it—and it was continuing to come down. So I was just totally exhausting myself.

And what we found was—the docs finally figured out what this was, Hoot. What happened was that—that there was a lot of input into the system other than just the electrical impulses coming out of my heart; there was the electrical energy that was coming from my muscles as I was holding myself down on that bar, and all of that had the tendency to run the—the monitor as if the heart rate was going down, when in fact it did not.

And the target heart rate, it was actually a little higher for that sustained period of time because I was running so hard to thinking that I was having the opposite effect.

Mr. LUJAN. One final—and because after the flight subsequent to yours, all the discussions we've had about—about whether it's operational or experimental.

How do you—you feel very confident, particularly, I guess Hoot and Steve who've been up more than—do you feel very comfortable, unsettled, like it's—like it's an operational vehicle, an experimental vehicle? What—what are your thoughts when you—when you go?

Commander GIBSON. My feeling, sir, was that it has never been what you'd call truly an operational vehicle. And there's obviously never been a machine that complex and that capable that we flew four times and said we're hereby operational and started flying it.

It's always going to be an experimental space rocket. It's always going to be a difficult proposition, and a system that leaves us very little capability to suffer too many serious malfunctions and come out of it. So it's always going—

Mr. LUJAN. Do you do that when you're getting on?

Commander GIBSON. Yes, sir. And I think everyone's pretty generally aware of that, and we're ready and willing to go do that, but it's always going to be that way. And so when we consider carrying passengers aboard the thing, we need to bear in mind that it is that type of a machine, that there is perhaps some risk involved in doing it, and that the benefits of carrying those particular people that we're carrying needs to outweigh the risk.

Mr. LUJAN. Steve, we discussed it last night at the chairman's dinner—and, incidentally, Mr. Chairman, that was a excellent tribute to you last night, and well deserved.

Dr. HAWLEY. Yes, sir. I would agree completely with what Hoot has said. We spend a very great deal of time—certainly it's part of the training, but also in general preparations for missions in support of other crews' flights, trying to understand as much about the shuttle and how it works as we can. I think we all feel an obligation to be as knowledgeable, as prepared, as trained, as we can be.

To try to foresee any eventuality, we have procedures for, I think, what many people would think are just very, very far out cases, but it's demonstrative of the depth with which we try to think everything through.

I think you always, when faced with the kind of technology and the kind of power that is the shuttle, hope that you thought of everything, wonder if you really have, and hope that you are prepared to deal with whatever may come. And I think we all feel when we got on board to launch we were as prepared as we could possibly be and were prepared to deal with whatever they threw at us. But you are never confident that you've thought of everything and you just do the best you can, and you accept that. Uncertainty, I suppose, is part of the business for which you've signed up.

Mr. LUJAN. Thanks. Thank you, Mr. Chairman.

Mr. FUQUA. Mr. Hall.

Mr. HALL. Thank you, Mr. Chairman.

I—I think I should say, and Congressman Chapman and I are from Texas and we have a football team down there that they call "America's Team"—and—and that's not too well accepted here in the Washington, DC area, but——

Mr. FUQUA. Or Atlanta.

Mr. HALL. Or Atlanta, yeah. We're still a little upset about that Atlanta situation.

But you are truly America's team and I think everyone here knows that. And I—I just want to say that as a member of the subcommittee, of Bill Nelson's subcommittee, how much I really appreciate Bill, and others members of the subcommittee appreciate him, because in his selection as a member of the crew, we couldn't have selected better because he allowed us to share his anxiety, his—and leading up to the launching, and he's certainly been generous with his time, with us, and with our constituents, and certainly with young people, that we have in the back of the room here, that space travel might be a day in and day out situation for them during their little lives as we look ahead, and it's because of the giving of your time and your abilities.

And, you know, to have you come here and be available to—to the world, through the cameras and through the press, I think means a lot to us as Americans. Because we don't have anything to hide—we are proud of what we're doing.

And, you know, for me to see Dr. Chang-Diaz—a Ph.D., MIT. Ph.D. simply loading a camera, and Steve having trouble winding a simple cord, it makes me know that y'all are down to Earth, on the level, and subject to the same human frailities that all of us have. But we must never forget, and I think the events of—of 1986 cry out to us, that you are the Columbuses and the Magellans of space, and it's a grateful nation that supports you.

I'm thankful to Lee Rich for the kindness she extends to us in—in making your members available to us, your knowledge available to us. And I think this is certainly part of the mission, and part of the journey, is to come back and report to the country that supports you. And I certainly support you.

Thank you, Mr. Chairman.

Mr. FUQUA. Thank you.

Mr. Chapman.

Mr. CHAPMAN. Thank you, Mr. Chairman. I just want to echo what Congressman Hall said and take this moment publicly to thank Hoot, you, and your lovely wife Rhea, for the assistance you gave me yesterday. Those here don't know that you gave your time after just coming to town to participate with me in making a couple of radio shows that will play back in east Texas on some 29 radio stations.

I truly believe that you gentlemen here today and, of course, the men and women of NASA, are our heroes in America. I appreciate the work you do. And I think Ralph has said it very well when he says you are out on a cutting edge of the frontiers that are going to keep America in the forefront as leaders in the world.

I appreciate you. I appreciate your work. And I look forward, as the newest member of Bill Nelson's committee, to making what contribution I can to the future of our space program. I appreciate each and every one of you.

Bill, thank you for the opportunity to serve on your committee, and, Mr. Chairman, to you as well.

Mr. FUQUA. Thank you.

Mrs. Meyers.

Mrs. MEYERS. I don't mean to prolong this, Mr. Chairman, but I just want to add my words and to thank you for your contribution to America, all of you. It is one of the real privileges and pleasures of serving on this committee that we get to come here and not only for these scientific aspects of space but also your thoughts and your feelings as you depart on these great adventures.

I am privileged to have heard you today. Thank you.

Mr. FUQUA. Mr. Packard.

Mr. PACKARD. You represent the last crew that's been in space, at least from this country, and I certainly hope that you will use your influence to help us get back into space. Thank you very much for being here this morning.

Mr. FUQUA. Thank you very much.

Bill.

Mr. BILL NELSON. Mr. Chairman, as a testimony to the team effort by so many other than just the people who are privileged to fly on the spaceship, I want to make particular note of the program manager of one of the shuttle experiments that we carried—Materials Science Laboratory—who passed away 2 weeks ago, Bud Wirman. His wife is my personal secretary who is here with us today, and in his memory it is—it is part—it underscores the fact that this is such a team effort. These astronauts fly the machine, but we have been given that privilege of flying only because of all the engineers who put together the machine and all the experiments, the people who daily watch the preparation, and then the launch, and then the bringing of the crew home. That's a real testimony to America's team.

Mr. FUQUA. Well, it certainly is, as you point out. And there are many thousands of people out there who don't get the recognition, but I think personally they recognize that they were part of that—that do the design and all of the planning and testing, and all the way through to launch and—and after landing. And so many, many thousands of people are—are involved, and I appreciate you mentioning that fact.

We do appreciate you being here and we thank you again for all the great contributions you are doing, and God bless you all. Thank you.

Commander GIBSON. Thank you, Mr. Chairman. And if I may, we, the crew of 61-C, would like to take just a moment to recognize your 24 years of leadership and your position as chairman of this committee, and present you with a small memento of our mission 61-C. I suspect by now you can probably cover your walls with these, but we want you to have one, and I guess we will probably be your last crew to have the opportunity to present you with this.

Mr. FUQUA. Thank you.

[Applause.]

Mr. FUQUA. I was just going to say, this is probably the last meeting of the Science and Technology Committee for the 99th Congress.

[Pause.]

Mr. FUQUA. I understand that might may be in error. [Laughter.]

So, next to the last.

Commander GIBSON. Mr. Chairman.

Mr. FUQUA. But we will have a meeting for the final report on the *Challenger* accident. But we want to thank you all for being here today and good luck to you in the future, and we will get flying.

Commander GIBSON. Mr. Chairman, there's more.

Mr. FUQUA. Oh, OK.

Commander GIBSON. I beg your indulgence for one more event, which is a very pleasurable one for me. And the schedules that we have had up until now that have not had our crew together have prevented me from awarding Bob Cenker and Congressman Bill Nelson with an award that a grateful Nation presents to them after their flight in space. And if I can have one of those I'd like to read it.

The National Aeronautics and Space Administration awards to Bill Nelson the NASA Space Flight Medal. This NASA Space Flight Medal is awarded to you as a crew member of U.S. spacecraft. You are one of a select group of pioneers who have widened the world's understanding and mastery of the new ocean of space. Your courage, dedication, and professional skill during the flight of STS 61-C contributed materially to the success of your mission. You have honored your Nation and your colleagues, and with this medal we are proud to honor you.

And it is my pleasure now to present Bob and Bill with their NASA Space Flight Medals.

Mr. FUQUA. Very good.

[Medal presentation.]

[Applause.]

Mr. FUQUA. Well, congratulations to both of you rookies. [Laughter.]

Mr. FUQUA. And not anymore.

Commander GIBSON. Thank you, Mr. Chairman.

Mr. FUQUA. Is that all, Hoot?

Commander GIBSON. Yes, sir, that's it. [Laughter.]

Mr. FUQUA. Well, thank you. Thank you all very much, and appreciate you being here. Thank you.

Mr. meeting is adjourned.

[Whereupon, at 11:30 a.m., the committee was adjourned, to reconvene subject to the call of the Chair.]